Preliminary Assessment of Lake Trout Spawning in the Niagara River

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The Fish and Wildlife Service and New York State Department of Environmental Conservation have been stocking lake trout in Lake Ontario since the 1970s as part of a restoration plan (Schneider et al. 1983). Lake trout assessment surveys in Lake Ontario have identified naturally reproduced fish in collections off the Niagara River since 1994. It is unknown where these fish are successfully spawning. Angler surveys show that lake trout are in both the lower Niagara River and the Niagara Bar in late fall during spawning time (Stantec 2004). Although lake trout are reef spawners there have been reports of lake trout spawning in large rivers. Mapping of bottom sediments in the Niagara River has identified several areas of coarse gravel and till that may provide suitable spawning habitat (Mudroch and Williams 1989).

Two types of egg samplers were selected for testing their ability to collect eggs in the Niagara River. A disk egg trap was developed in 1988 and has been successfully used in various areas around the Great Lakes to collect lake trout eggs (Marsden et al. 1991, Marsden 1994, and Marsden and Chotkowski 2001). This type of egg sampler has not been tried in fast flowing water. The egg mat sampler was developed to collect sturgeon eggs and has been successfully used in a variety of rivers (McCabe and Beckman 1990, Marchant and Shutters 1996, and Caswell et al. 2002).

The purpose of this pilot study is to identify lake trout spawning areas in the lower Niagara River and to test the effectiveness of two types of egg samplers under the fast-flow conditions found in the river.

Methods

Two types of egg samplers were used in this study. The disk trap consisted of two polystyrene plates, each in the shape of a petrie dish, to fit on either side of a polyvinyl chloride (PVC) collar 20.3 cm in diameter and 3.8 cm high (Figure 1a). The surface of each plate has two indented cones with 1.3 cm holes in their centers. A u-shaped PVC clip holds the parts together. The mat sampler is made of furnace filter mat (Hammock Precision Aire, hog hair filter fabric with latex coating, or similar) attached using a bungee cord to a standard cinder block (Figure 1b). Four lines of traps and mat samplers were constructed. A line consisted of 10 to 15 disk egg traps connected to a nylon line or metal chain every 1-2 meters using swivel hooks and two mat samplers covering the cinder blocks tied at each end. The cinder blocks at each end also acted as the anchors. A buoy was connected to each of the cinder blocks. Three nylon lines with 10 disk egg traps and 2 egg mat samplers each, and one metal chain with 15 egg traps and 2 egg mat samplers were used.

The egg sampling lines were deployed on two dates, November 8th and November 17th from a boat at several locations in the Niagara River in water depth of 10m or more (Figure 2). The lines were kept in the water from a minimum of 24 hours up to 12 days. Eggs collected from all the samplers in a line were put into one labeled sample jar and preserved in 70% alcohol for counting and identification. Eggs counts were recorded by sampler and by line.

Figure 1a. disk trap and connection to nylon line.

Figure 1b. Mat sampler.

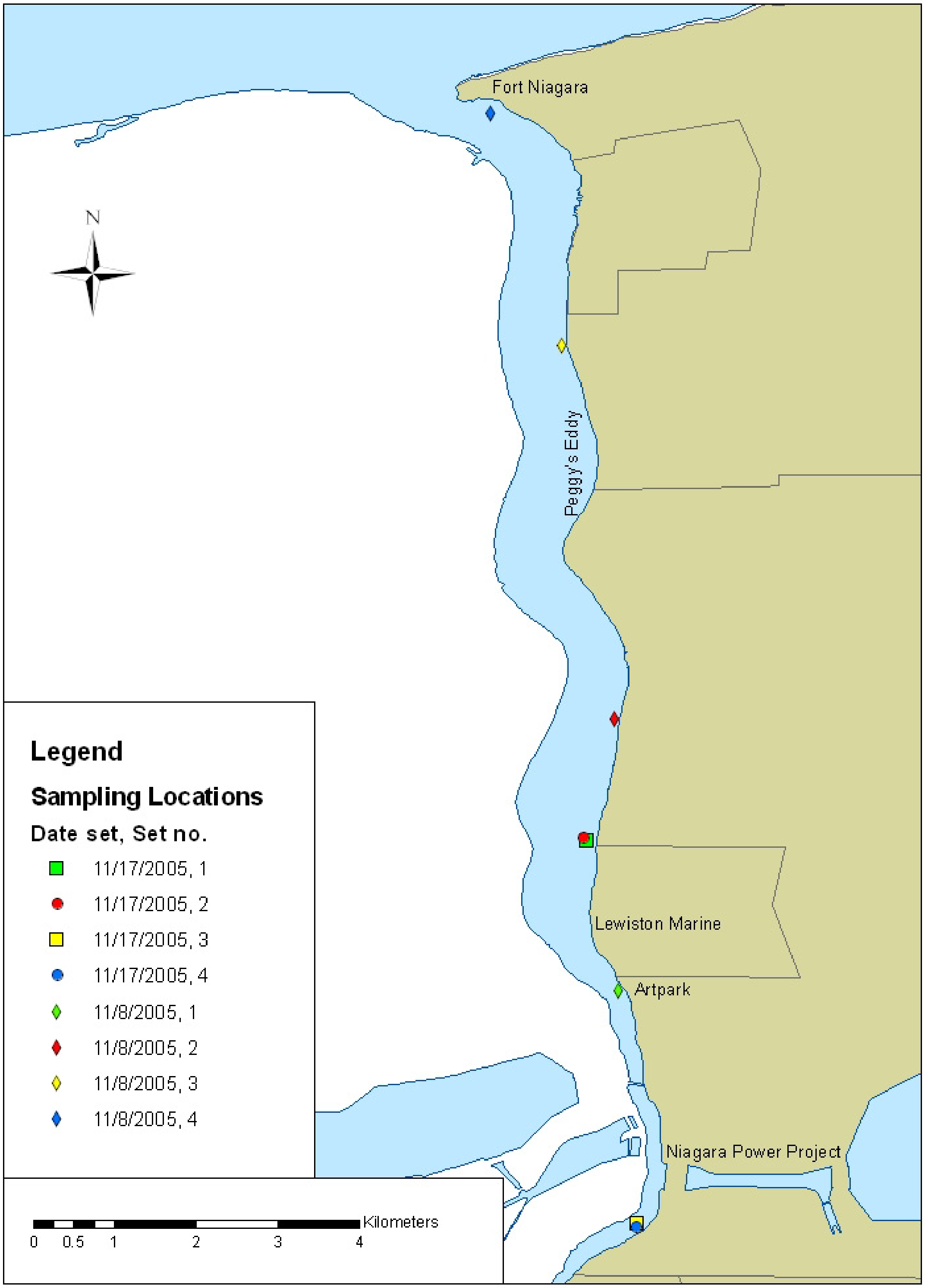

Figure 2. Map of area showing location of lines for each date in November, 2005.

Results

Two of the lines set on November 8th were retrieved within 24 hours and two were retrieved within 48 hours (Figure 2, Table 1). Only two lines were able to be retrieved on November 9th due to a storm front that moved in quickly and prevented us from retrieving the other two lines. They were retrieved the next day. Due to high loss of traps at the Artpark site, and the high amount of sediment found in the traps by the Ft. Niagara boat launches, it was decided not to reset at these locations (Table 2).

On November 17, the lines were set in pairs parallel with the shoreline and one closer to shore in two locations (Figure 2). The samplers were retrieved on November 29th for a total of 12 days in the water, and eggs were found in all four set lines (Table 2). An average of 0.031 eggs/trap/day was found on the mat samplers (Table 2). The number of eggs per disk trap ranged from 0 to 10, averaging 0.229 eggs/trap/day (Table 2). Of the 123 eggs collected, some were obviously dead or only pieces of an egg. Approximately 80 appeared to be alive. They were generally opaque to translucent pale yellow and averaged 5.38 mm in diameter (range 4.5-6.0 mm). Although the eggs were not identified at time of collection, they are within the size range and color of lake trout eggs (Appendix A). DNA analysis of the eggs determined that they were 100% lake trout eggs (Appendix B).

Discussion

This study indicated that spawning by lake trout was initiated sometime between November 17 and 29. It is unknown when spawning ended because the lines were not reset after November 29. The number of eggs collected by the disk samplers indicates spawning is occurring in the river. The number of eggs collected in the disk samplers during this study is higher than collections on Stony Island Reef (Marsden et al. 1991). Due to the high flow of the river, the eggs collected in the samplers are likely a combination of ones spawned in that location and ones that drifted downstream from the actual spawning location.

While both samplers collected eggs, the disk samplers were more effective than the egg mat samplers. The mat samplers likely did not retain the eggs as well as the disk sampler in the high flow conditions. Though the disk sampler retained more eggs, it was not effective at every site in the river. In areas of very high flows, such as the Artpark site, the samplers came apart despite having a u-shaped clip holding the sides together.

All sites downstream of Lewiston Marine were selected because they were in areas identified as having a gravel/till substrate (Mudroch and Williams 1989). Sediment and vegetation accumulated in the egg samplers in these locations. The deeper set (no. 2) downstream of Lewiston Landing had the highest number of eggs, but also included sediment and plant fragments. This indicates that these areas may not be suitable for lake trout egg development. The site upstream of the Power Project is an area of slower water that is partially sheltered from the flow by a finger of boulders that extend out from shore. The bottom is a mix of rocks and boulders. This area seems to remain clear of sediment, as only mollusk shell fragments were found in the egg traps. This area may have suitable substrate for egg development. Unfortunately, this area is also subject to daily water fluctuations that can be as great as 12 feet per day (URS et al. 2005).

The next step would be to determine if there is any successful hatching in the Niagara River. Since we were unable to identify specific spawning habitat, an icthyoplankton net may be the best method to use for collecting lake trout larvae.

Table 1. Date, time, location, depth and temperature of set lines of egg samplers.

Date set	Time set	Date pulled	Time pulled	Set No.	Description	Lat.	Lon	Mean Depth (ft)	Surf. Temp. set	Surf. Temp pulled
11/8/2005	10:30	11/10/2005	10:30	1	Artpark - under big metal sculpture	43.16333	79.04667	17.5	11.5	11.3
11/8/2005	11:00	11/9/2005	10:00	2	by red cliffs downstream of Lewiston Marine	43.19333	79.04700	23.0	11.4	11.3
11/8/2005	11:20	11/10/2005	10:50	3	downstream of Peggy's Eddy at outfall and deck with flagpole	43.23433	79.05283	17.5	11.5	11.3
11/8/2005	11:35	11/9/2005	11:20	4	Off Ft. Niagara boat launches	43.26000	79.06067	18.5	11.4	11.3
11/17/2005	10:32	11/29/2005	10:20	1	downstream of Lewiston Marine off round stone lighthouse home	43.17988	79.05008	21.0	9.3	7.3
11/17/2005	10:40	11/29/2005	10:08	2	downstream of Lewiston Marine off round stone lighthouse home	43.18025	79.05045	24.5	9.3	7.3
11/17/2005	10:10	11/29/2005	9:40	3	Upstream of Niagara Power Project in shallows	43.13784	79.04450	12.6	9.2	7.3
11/17/2005	10:15	11/29/2005	9:53	4	Upstream of Niagara Power Project in shallows	43.13727	79.04468	11.5	9.2	7.3

Table 2. Collections of eggs in the Niagara River.

Date set	Date pulled	Set No.	Description	No. of traps	No. of filters	No. of eggs	Eggs/ trap/ day	Comments
11/8/2005	11/10/2005	1	Artpark - under big metal sculpture	2 of 10 recovered	2	0	0	
11/8/2005	11/9/2005	2	by red cliffs downstream of Lewiston Landing	10	2	0	0	
11/8/2005	11/10/2005	3	downstream of Peggy's Eddy at outfall and deck with flagpole	10	2	0	0	
11/8/2005	11/9/2005	4	Off Ft. Niagara boat launches	15	2	0	0	Traps filled with fine sediment
11/17/2005	11/29/2005	1	downstream of Lewiston Landing off round stone lighthouse home	15	2	filters-0 traps-8	0 0.044	Traps partially filled with fine sediment and vegetation
11/17/2005	11/29/2005	2	downstream of Lewiston Landing off round stone lighthouse home	10	2	filters-1 traps-57 loose-10	.042 0.475	Traps partially filled with fine sediment and vegetation
11/17/2005	11/29/2005	3	Upstream of Power Project in shallows	10	2	filters-1 traps-42	0.042 0.35	Traps partially filled with zm shell fragments
11/17/2005	11/29/2005	4	Upstream of Power Project in shallows	5 of 10 recovered	2	filters-1 traps-3	0.042 0.05	Traps partially filled with zm shell fragments

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Appendix A
Spawning and Egg Characteristics of salmonids (information from Auer 1982).

Species	Spawning season	Spawning Temp.	Egg color	Egg Dia. (mm)	Other characteristics
Lake trout	August - December	4.4 C, 2.8-14.4 C	pale amber translucent *	5.0-5.6 5.0-6.0**	egg semibuoyant
pink salmon	mid-July - October	11 - 13 C	orange-red	6.4 6.0**	
coho salmon	September - October	NA	red-orange	4.5-6.0**	demersal
chinook salmon	September - October	NA	red-orange	6.0-7.0**	demersal
Rainbow trout	spring and fall	10 - 15.5 C	pink-orange	4.46 3.0-5.0**	
Atlantic salmon	October - November	7.2-10.0 C	pale orange	5.0 - 7.0	Water depth at spawning sites is typically 30 cm to 61 cm and water velocity averages 60 cm per second
brown trout	October - November	6.7 - 8.9 C	amber	4.4-4.5 3.2-5.0**	

* color information came from internet source http://www.newton.dep.anl.gov/natbltn/500-599/nb553.htm
** size information is from Smith 1985.

Appendix B. DNA ANALYSIS OF UNKNOWN SPECIES EGGS

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OBJECTIVE: To determine the species origin of fish eggs collected from the Niagara River. Eggs were thought to be from lake trout. If lake trout were determined to have produced these eggs, results would be used to direct monitoring and assessment efforts to determine reproductive capacity on the reef where the eggs were collected, and to monitor for juvenile survival.

METHODS: Two vials of fish eggs spawned by an unknown species were received in our lab in February of 2006 from the FWS Lower Great Lakes FRO. Embryos were excised from the outer membrane and digested with ProteinaseK for approximately 3 hours. DNA was isolated by boiling in the presence of Chelex 100 resin. Ribosomal DNA was amplified using primers flanking the 18S and 5.8S regions of the first internal transcribed spacer region (ITS-1) described by Pleyte et al. (1992). Resulting PCR products were purified and used as template for sequencing reactions.

RESULTS: Sequences of approximately 735 base pairs were obtained from three individual embryos sampled from vial # 234. Extracted embryos from vial # 4 did not yield sufficient quality DNA for sequencing. Sequences were compared to existing ITS-1 sequences stored in GenBank (www.ncbi.nlm.nih.gov/Genbank/). Existing sequences included all members of the *Salvelinus,Oncorhynchus, Salmo,* and other putative genera and species that may have been the source for the unknown origin eggs. All embryo sequences were a 100% match to lake trout (*Salvelinus namaycush*) ITS-1 sequences published by Reed et al. (2000). The next closest match was arctic charr ITS-1 sequence with 95% base pairs matching our embryo sequences.

CONCLUSION: Due to the results of the DNA sequencing, the eggs of unknown origin were determined to have been deposited by lake trout (*Salvelinus namaycush*).

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